Nuclear Power Industry Experience with Risk-Informed Regulation

Workshop on Risk Assessment and Safety Decision Making Under Uncertainty

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NUCLEAR ENERGY INSTITUTE

Nuclear Energy Institute

- NEI is the Washington, DC based organization of the US nuclear power industry
  - Addresses policy and regulatory matters
  - Provides generic regulatory interface with NRC
  - All US nuclear operating companies are members, along with universities, suppliers, consultants, others

Risk-Informed Performance Based Regulation

- Industry is a strong supporter of risk-informed regulatory decision making
- Risk-informed regulatory methods lead to enhanced safety and economics of operation
- Provides for more objective safety focus
- NEI supports PRA development and consensus standards
- Our focus is on using the PRA in applications

Background

- 10 CFR Part 50 addresses reactor safety and is largely deterministic
- US Industry has over 3000 reactor years of operating experience
  - Comprensive data on equipment performance, initiating events
  - Robust infrastructure and significant experience with PRA
- Many applications have been developed

NRC Regulatory Framework

- **Safety goal policy statement (1987)**
  - How safe is safe enough?
  - Qualitative and quantitative health objectives
  - Subsidiary objectives for early and latent health effects
  - Supports backfit rule (10 CFR 50.109)
- **PRA policy statement (1995)**
  - Use PRA in regulatory matters
  - Realism in analysis as supported by state of the art
  - Use PRA to reduce unnecessary burden as well as to identify new requirements

Initial Industry PRA Development

- Individual plant examination (1988)
  - All plants developed internal events at power PRAs to identify vulnerabilities
  - Many plant improvements implemented
- Individual plant examination for external events
  - Seismic, floods, high winds, fire
  - PRA and other techniques used

NRC Regulatory Guide 1.174

- Regulatory Guide 1.174 (published 1998) sought to implement PRA policy
- Use core damage frequency and large early release frequency for regulatory decision making
- Small calculated increases in risk were acceptable, in light of:
  - Delta risk and overall plant risk
  - Meeting current regulations
  - Defense in depth
  - Safety margins
  - Performance monitoring

PRA Technical Adequacy

- Addressed through consensus standards and peer review
- Standards endorsed through NRC Regulatory Guide 1.200
- Obviates need for direct NRC review of base PRA model
- Uncertainties primarily addressed on an application specific basis

Treatment of Uncertainties

- Other elements of the "risk-informed" process are in part included to address uncertainties
- Margins to safety goals
- Sensitivity studies
- In some cases, concern with uncertainties can lead to attempts to bound outcomes directly in the PRA, versus striving for realism
- Fire and seismic initiators modeling uncertainties are more challenging with respect to internal events

Maintenance Rule

- **10 CFR 50.65 implemented in 1995**
  - First and important risk-informed performance based rulemaking
  - Provided for monitoring of equipment performance and for risk assessment and management of maintenance activities
  - Scope not limited to safety related equipment
  - Used PRA to determine more risk significant SSCs, and for balancing reliability and availability

NRC Regulatory Reform Efforts

- NRC embarked on fundamental regulatory reform effort in late 1990s
- Objective was to provide more risk-informed performance based approach for 10 CFR Part 50
- Sequence of rulemakings:
  - Hydrogen control rule, (removal of recombiners)
  - Rulemaking to enable risk-informed scope of graded quality assurance and other similar regulatory requirements
  - Rulemaking on Emergency Core Cooling realistic break size

10 CFR 50.69, Risk-Informed Scope of "Special Treatment" Requirements

- Provides voluntary risk-informed alternative scope of applicability for 11 "special treatment" regulations
  - Equipment qualification, seismic qualification, quality assurance, maintenance rule, reporting requirements, others
- Final Rule issued and Regulatory Guide on risk classification approved by NRC
- Significant potential benefit
- Still awaiting implementation

Proposed 10 CFR 50.46a Alternative Break Size for Emergency Core Cooling Requirements

- Seeks to provide alternative requirements for very large (infrequent) design basis pipe breaks
- Expert elicitation used to develop pipe break frequencies leading to “transition break size” (TBS)
- Mitigation for above TBS breaks is required, but no assumptions of concurrent single failure and loss of offsite power
- Rule has been modified (additional limitations) due to ACRS and NRC staff concerns
- Awaiting final rule at end of 2010

10 CFR 50.48c, Risk Informed Fire Protection

- Provides risk informed alternative to existing deterministic fire protection regulations
- Allows consideration of ignition sources, targets, fire modeling, PRA risk metrics
- Challenging due to complexity, schedules, and technical issues with methods
- Pilot approved, and over half of plants are implementing
- Has led to extensive development of fire PRA

Technical Specifications (Equipment Configuration Control)

- **Widely implemented**
  - Equipment out of service time extensions (e.g. diesel generator allowed outage time)
  - Missed surveillance and mode restraints initiatives
  - Equipment surveillance test interval removal to licensee control
- **Implementation underway**
  - Flexible out of service times using PRA to calculate acceptable duration of out of service condition

NRC Reactor Oversight Process

- Uses risk to inform reactor safety cornerstone (inspection finding significance determination, performance indicators)
- Voluntary in concept (no underlying regulation) but used by all licensees
- Has become increasingly complex, but provides improved safety focus over previous subjective process
- "Number focused" and large consumer of plant and NRC PRA resources

Other Applications

- Risk informed weld inspection
- Risk informed pump and valve testing
- License Renewal (level 3 PRA to address cost beneficial improvements)
- Containment integrated leak rate testing interval

New Plant Designs

- Plants being licensed under Part 52 have benefited from PRA insights at the design stage
  - Very low internal events CDF
  - External initiators (seismic, flooding) likely to dominate risk
  - These plants are required to perform and maintain a PRA meeting scope of Reg Guide 1.200

New Plant Designs

- New plant license applicants are generally not pursuing risk-informed initiatives as part of initial licensing
- NRC addressing policy aspects of low risk plants
  - Concern with potential for erosion of safety margins
  - Reactor oversight process
  - Licensing decisions

The Challenge

- **Risk-informed regulation presents a cultural challenge for industry and the regulator**
  - **Both have much prior experience with deterministic bounding approaches versus realistic analyses**
  - **PRA is often viewed as a black box that is not readily understood except by PRA experts**
  - **Technical adequacy of PRA is necessary but not always sufficient to enable success**
  - **Education on risk concepts important**

Lessons Learned

- NRC support for regulatory reform is dependent on:
  - Industry performance
  - Chairman, Commission and senior NRC management support
- Industry support dependent on:
  - Value proposition
  - Infrastructure investment
  - Demonstrated successes of applications

Lessons Learned

- Risk applications can become “number focused” and moved away from integrated decision process
- PRA requires time to evolve to reasonably realistic methods
  - Internal events has benefitted from over 20 years of methods development
  - Fire, seismic, shutdown are greater challenges

Summary

- Risk applications have been successfully developed and implemented
- Safety focus and burden reduction are achievable
- Progress is evolutionary, but over time significant regulatory improvement can be realized
- Work in progress